

REMARKS

Claim 15 is amended. Claims 15-22 and 35-41 are pending in the application.

Claims 17-20 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. The Examiner indicates that the recited “consisting of one or more members of the group consisting of O₂, O₃, and optionally H₂ and NH₃ renders the claims indefinite because it is unclear if the plasma is generated from hydrogen gas alone, how the utilized plasma can be oxygen-comprising plasma”. Without admission as to the propriety of the Examiner’s statement, independent claim 15 is amended to recite a plasma generated from a gas having active components consisting of one or more members of the group consisting of O₂, O₃, H₂ and NH₃, the gas comprising at least one of O₂ and O₃. Accordingly, applicant respectfully requests withdrawal of the § 112, second paragraph, rejection of claims 17-20 in the Examiner’s next action.

Claims 15-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over various cited combinations of Mathews (5,658,829), Hillyer (2006/0128159), Allen (5,970,373), Sharan (5,747,116) and Brown (5,780,359). The Examiner is reminded by direction to MPEP § 2143 that a proper obviousness rejection has the following three requirements: 1) there must be some suggestion or motivation to modify or combine reference teachings; 2) there must be a reasonable expectation of success; and 3) the combined references must teach or suggest all of the claim limitations. Claims 15-22 are allowable over the various cited combinations of Mathews, Hillyer, Allen, Sharan and Brown for at least the reason that the references, individually or in combination, fail to disclose or suggest each and every element in any of those claims, fail to provide a basis

for a reasonable expectation of success, and fail to provide motivation for combination.

Independent claim 15 recites etching material beneath a masking layer to outwardly expose a conductive silicon-comprising material at a base of an opening, removing a masking layer from the substrate, and subsequently utilizing oxygen-comprising plasma to remove a residue from the outwardly exposed conductive silicon-comprising material, where the plasma is generated from a gas having active components consisting of one or more of O_2 , O_3 , H_2 and NH_3 . Mathews discloses etching BPSG to form a contact opening utilizing a dry etch with argon to minimize polymer buildup during the etch process (col. 3, ll. 38-42). Mathews additionally discloses subsequent removal of masking layer 42 (col. 3, ll. 43-44). Such disclosure does not teach or suggest the claim 15 recited etching to expose a conductive silicon-comprising material followed by removal of a masking layer and subsequent utilization of an oxygen-comprising plasma to remove residue from the outwardly exposed conductive silicon-comprising material. Nor does the use of argon during dry etch to minimize polymer buildup during the etch process as disclosed by Mathews provide motivation to perform a post etch plasma removal of residue as recited in claim 15.

Hillyer is indicated as being relied upon as teaching removal of an etch residue by exposing a substrate to a plasma comprising oxygen and hydrogen where the hydrogen plasma can be formed from ammonia with reference to paragraphs 28-29. Referring to Hillyer at paragraphs 28-29, such discloses simultaneous removal of resist layer 20 and residue 26. Such does not disclose or suggest the claim 15 recited removal of a masking layer and subsequent utilization of an oxygen comprising plasma to remove residue from an outwardly exposed conductive silicon-comprising material. Further, referring to

paragraph 29 of Hillyer, such specifically indicates that where the resist strip is performed independent of the residue removal, the residue removal is performed with methane or hydrogen gas. Accordingly, such specifically teaches away from utilizing an oxygen-comprising plasma to remove a residue in a step independent from resist removal. Accordingly, Hillyer is unavailable as a basis for a 103 rejection relative to the claim 15 recited after removing a masking layer from a substrate, utilizing an oxygen-comprising plasma to remove a residue from an outwardly exposed conductive silicon-comprising material.

At page 5 of the present Action the Examiner indicates reliance upon Allen as disclosing use of an oxygen-comprising plasma for removing residual matter. However, Allen specifically indicates using such oxygen-comprising plasma for removal of residue from a dielectric (nitride) material. Allen does not disclose or suggest the claim 15 recited removal of residue from an outwardly exposed conductive silicon-comprising material. Further, a problem specifically addressed by the present invention is to remove residue from a conductive base surface after formation of a contact opening. Neither of Mathews or Allen addresses this issue. Nor does the Allen disclosure of removing residue from a nitride material provide a basis for a reasonable expectation of achieving the claim 15 recited removal of residue from an outwardly exposed conductive material using a plasma generated from a gas having active components consisting of one or more members of O₂, O₃, H₂ and NH₃. Accordingly, in combination Allen and Mathews fail to disclose each and every element of claim 15, fail to provide a reasonable expectation of success and additionally fail to provide motivation for combination.

At pages 5-6 of the present Action the Examiner indicates reliance upon Sharan as

disclosing exposing monocrystalline silicon and removal of an unwanted material utilizing hydrogen plasma. However, the hydrogen plasma disclosed by Sharan does not teach, suggest or contribute towards suggesting the oxygen-comprising plasma recited in claim 15. Further, the Sharan disclosure indicates removal of an oxide material and does not address the problem addressed by claim 15. Accordingly, as combined with Mathews and Allan, Sharan does not provide motivation for combination or provide a basis for a reasonable expectation of achieving the claim 15 recited removal of residue from an outwardly exposed conductive silicon-comprising material using an oxygen-comprising plasma. Accordingly, independent claim 15 is not rendered obvious by the combination of Allen, Mathews and Sharan.

At pages 6-7 of the present Action the Examiner indicates reliance upon Brown as disclosing a stripping process conducted at a temperature ranging between 20° to over 100°C with benefits of using higher temperatures. However, Brown discloses appropriate temperatures for post metal-etch processing. Brown does not contribute toward suggesting the claim 15 recited post etch utilization of an oxygen-comprising plasma to remove residue from an outwardly exposed conductive silicon-comprising material where the plasma is generated from a gas having active components consisting of one or more of O₂, O₃, H₂ and NH₃. Nor does Brown address the issue of residue removal after formation of a contact opening. Accordingly, such does not provide motivation for combination. Nor does the disclosed temperature, in the context disclosed, contribute toward providing a reasonable expectation of achieving the recited removal of residue from an outwardly exposed conductive silicon-comprising material. Therefore, the combination of Brown, Mathews, Allen and Sharan fails to disclose or suggest each and every element in

independent claim 15, fails to provide a reasonable expectation of success, and fails to provide motivation for combination. A *prima facie* case of obviousness has not been established by the various cited combinations of Mathews, Allen, Sharan, Brown and Hillyer. Claim 15 is therefore allowable over the cited references.

Dependent claims 16-22 are allowable over the various cited combinations of Mathews, Hillyer, Allen, Sharan and Brown for at least the reason that they depend from allowable base claim 15.

Claims 35-41 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over a combination of Mathews, Hillyer and Sharan or in the case of claims 36 and 37 over the combination of Mathews, Hillyer and Sharan in further view of Brown. Independent claim 35 recites dry etching a layer of BPSG to expose a monocrystalline silicon substrate material at a base surface of an opening, and forming a carbon-containing polymer residue at least partially over the substrate material at the base of the opening. Claim 35 additionally recites removing the photoresist layer and subsequently plasma etching to remove the carbon-containing polymer residue substantially selectively relative to BPSG and relative to the monocrystalline silicon substrate material utilizing a plasma generated from one or more of O₂, O₃, H₂ and NH₃. As indicated above, Mathews does not disclose or suggest forming an opening and subsequently removing residue from a base surface of the opening. As further indicated, Mathews specifically indicates minimizing polymer buildup during formation of a contact opening and therefore does not provide motivation for the claim 35 recited post etch residue removal processing.

As further indicated above, Hillyer teaches away from the recited independent removal of a masking layer and subsequent utilization of oxygen-comprising plasma to

remove a residue from an outwardly exposed conductive silicon-comprising material. Accordingly, Hillyer is unavailable as a basis for a 103 rejection of claim 35.

Neither of Sharan or Brown contribute toward suggesting the claim 35 recited removal of carbon-containing polymer residue from a monocrystalline substrate where the removal is substantially selective relative to BPSG layer and relative to the monocrystalline silicon substrate material. Nor does any of the cited references address the problem of post etch residue removal from a monocrystalline silicon substrate material where the residue material is removed substantially selectively relative to BPSG and monocrystalline silicon material. Accordingly, the references fail to provide motivation for combination. Additionally, as discussed above with respect to claim 15 the combination of Mathews, Hillyer, Sharan and Brown fails to provide a reasonable expectation of successful removal of carbon-containing polymer residue from a monocrystalline silicon substrate material, and also fails to provide a reasonable expectation of substantial selectivity as recited in claim 35. Therefore, claim 35 is not rendered obvious by the various cited combinations of Mathews, Hillyer, Sharan and Brown and is allowable over these references.

Dependent claims 36-41 are allowable over the cited combinations of Mathews, Hillyer, Sharan and Brown for at least the reason that they depend from allowable base claim 35.

For the reasons discussed above, claims 15-22 and 35-41 are allowable. Accordingly, applicant respectfully requests formal allowance of such claims in the Examiner's next action.

Respectfully submitted,

Dated: April 30, 2007

By: Jennifer J. Taylor
Jennifer J. Taylor, Ph.D.
Reg. No. 48,711